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Research on Optimization Design of Hazardous Chemicals Logistics Safety Management System Based on Big Data

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In view of the frequent occurrence of hazardous chemicals transportation accidents, this paper studies the logistics safety management of hazardous chemicals based on large data technology, aiming at better realization of safe transportation and management optimization of hazardous chemicals. Firstly, this paper explains the theoretical research of big data management and logistics informatization, and analyzes the effect of big data on hazardous chemicals logistics transportation from the aspects of data, management coordination, supervision organization and so on. Then by introducing the current situation of hazardous chemicals transportation accidents in China and analyzing the problems existing in the current transportation supervision process, this paper puts forward the optimization design of hazardous chemicals logistics safety management system based on the concept of big data. Finally, this paper analyzes the effect of this model from its application in Zhenhai District of Ningbo City. The research in this paper is helpful to promote the informatization of logistics transportation and has important theoretical guiding significance to the transportation safety of hazardous chemicals.

1. Introduction

Hazardous chemicals are essential chemical raw materials in China's economic construction. Hazardous chemicals have the characteristics of corrosiveness, oxidation and toxicity, with safety risks in the production, transportation and storage, especially in the process of logistics transportation (Hu and Raymond, 2004). According to statistics, from 2006 to 2014, there were a total of 3,234 dangerous chemical accidents, with nearly 400 casualties. In 2011, there was an explosion resulting from a rear impact accident between two heavy oil tankers on the Lanlin Expressway, which caused 4 deaths and 1 serious injury; in 2012, 36 people were killed when a methanol tanker rear-ended a sleeper car at Baomao Expressway. The high risk existing in the transportation of hazardous chemicals has caused the high attention of all circles, and it is of great significance to improve the supervision ability of transportation management and the Informa ionization in the transportation process (Tan et al., 2015).

China has made some achievements in the research of hazardous chemicals logistics transportation. Some scholars use wireless sensor technology to track and locate transport vehicles in real-time and realize real-time sharing of GPS data (Jr and Smith, 2010). Some scholars have put forward the optimization of freight transportation in petrochemical enterprises from the aspects of inventory management, vehicle dispatching and distribution scheme. However, there is a lack of research on the optimization of safety management of hazardous chemicals logistics based on big data (Grifoll and Cohen, 1994).

With focus on the research of combining big data and hazardous chemicals logistics, this paper firstly explains the theoretical research of big data management and logistics informatization, then analyzes the problems existing in the logistics transportation of hazardous chemicals in China, and the effect of big data on logistics transportation from many aspects. Finally, this paper realizes the optimization design of hazardous chemicals logistics management system based on big data and verifies the effectiveness of the optimization management system through practical application.

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2. Theoretical Foundation and Research Background

2.1 Connotations of big data

Big data feature 4V, which represents Volume, Variety, Velocity, and Value, respectively. Volume means that that measurement level of the data set rises from GB to TB to PB, even EB and ZB (Wu et al., 2013); Variety refers to the development of various types of mobile interconnection devices, Internet of Things, and mobile intelligent devices, data types show various development; Velocity refers to "second-graded law" of data processing; Value with low density mean that high-value data are not directly proportional to the total amount of data (Lazer et al., 2014).
Big data is an embodiment of information technology-based data form, and its traceability based on the theoretical basis of information technology is shown in Figure 1.

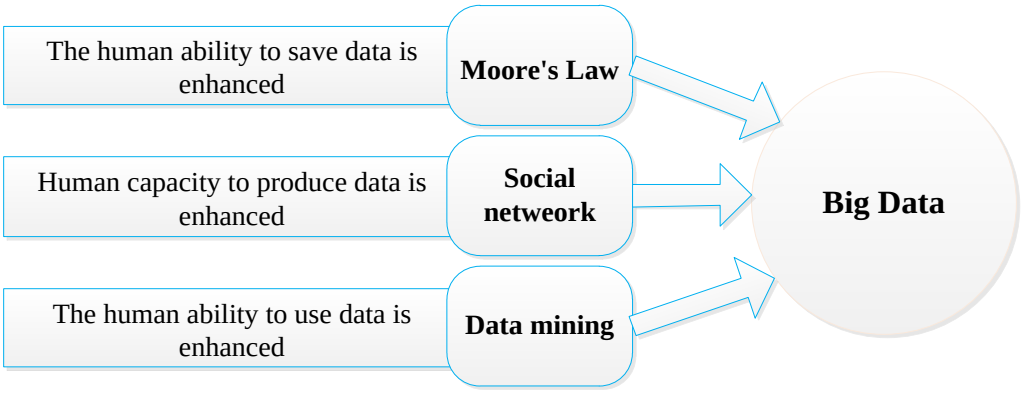

Figure 1: Big data theory of information technology

The technology of big data has been developed rapidly since 2010. The technological progress in producing, storing and utilizing data has laid a solid foundation for the application of big data in various industries (Kovar and Gleicher, 2004).

2.2 Logistics management informatization and application of big data in logistics transportation

2.2.1 Logistics management informatization

Logistics information technologies are mainly divided into the following five types: 1. Bar code technology, for effective management and identification of transported goods through bar code; 2. Composite code technology, combining one-dimensional code and two-dimensional code to provide help for logistics supply chain; 3. GPS technology, using global positioning system to improve logistics management efficiency; 4. GIS, providing help for the route selection of logistics transportation; 5. RFID, which is a kind of logistics management information technology not limited by distance (Max et al., 1996).
Logistics management informationization has the characteristics of systematicness, objectivity, dynamics, distribution and sharing. At present, logistics management systems mainly include EOS electronic automatic ordering system, POS sales time information system and CAO computer-aided ordering system (Zhang, 2011).

2.2.2 Effect of big data on the transportation of hazardous chemicals

(1) Data. The big data of logistics provide the supervision means for the transportation of hazardous chemicals. The data connection and real-time data sharing of people, cars, roads, goods and environment make the hazardous chemical logistics online and data-based, and the whole life cycle monitoring and management is realized through the pre-, mid-and post-logistics transportation (Wang, 2011).
(2) Management collaboration. The logistics transportation of hazardous chemicals involves traffic, security check, quality inspection, industry and information department, environment department and other departments. It is easy to make management difficult due to the inconsistency of management standards and law enforcement requirements in the process of collaborative management and cross-function. The big data platform provides information sharing under the networked environment for each part, and realizes collaborative supervision across departments and regions (Zhang and Cheng, 2014).

(3) Regulatory organization. Through the virtualization of traffic, inspection, environmental protection and other parts of the management functions to develop a network supervision organization platform, which may be more flexibly applied in the entire life cycle of hazardous chemical logistics transportation.

2.2.3 Analysis of problems in logistics transportation of hazardous chemicals

Along with the rapid development of China's chemical industry and economy, the tonnage of chemical transportation increases year by year. The lessons of accidents during the transportation of hazardous chemicals have aroused great attention from the functional departments. Laws and regulations such as Safety Management Regulations for Hazardous Chemicals, Regulations on the Management of Transportation of Dangerous Goods on Road and Several Opinions on Strengthening the Safety Supervision and Administration of Transportation of Hazardous Chemicals have been promulgated successively (Liu et al., 2004).
The lack of protection, insurance and signal devices in the process of transportation of hazardous chemicals is the direct cause of accidents, and low awareness of safety production, insufficient preventive measures for accidents and unfamiliarity with safety transportation regulations are indirect causes. It can be seen that although the transportation of hazardous chemicals in China has been legalized from the angle of laws and regulations, there are some problems such as unstrict implementation, loose management, incomplete logistics supervision information, and difficult information sharing in practical supervision and operation.

3. Optimization Design of Safety Management System of Hazardous chemicals Logistics Based on Big Data

3.1 Optimization design of safety management system

For the problems existing in the logistics transportation of hazardous chemicals in China, the safety management of logistics transportation is optimized by using big data technology. Based on the principles of systematization, individuation and rationalization, logistics safety management optimization provides accurate, real-time and cost-effective logistics transportation data for the transportation of hazardous chemicals (Wang, 2017).

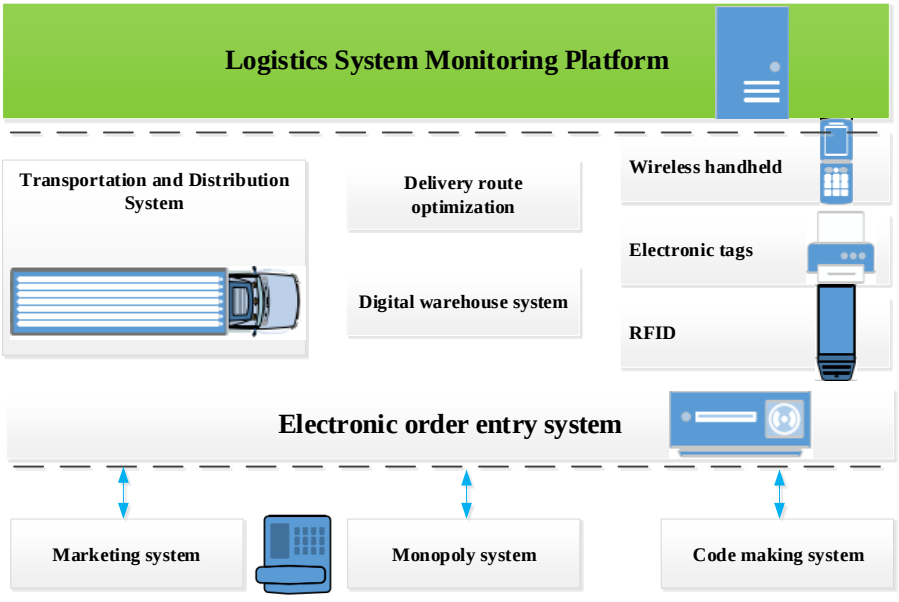

Figure 2: The logistics management system

Figure 2 shows a conventional hazardous chemical logistics management system, which is an integrated application of logistics monitoring and management platform, distribution route optimization, digital warehousing system, electronic order system, transportation and distribution system and other external systems. But in terms of business processes, soft environment, and big data mining, it's necessary to optimize and redesign (Liu et al., 2017).
The optimization of hazardous chemicals logistics management system based on big data technology mainly focuses on three aspects such as business process optimization, soft environment optimization and

optimization of big data in logistics. Figure 3 shows the optimization design diagram of hazardous chemicals logistics system.

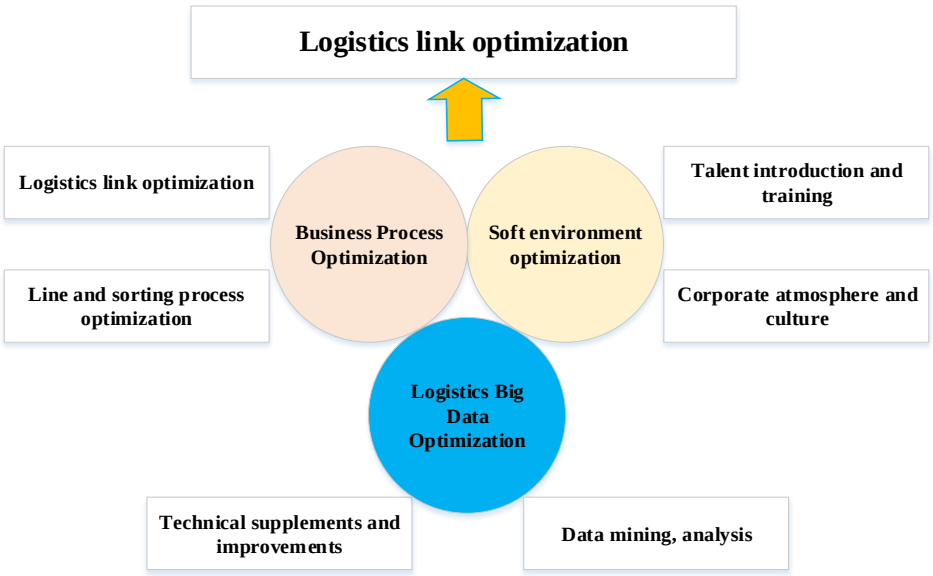

Figure 3: Optimization design of hazardous chemicals logistics system

3.1.1. Business process optimization

Owner's process optimization is mainly to optimize the route and sorting of hazardous chemicals from the process of production, inspection, transportation and use. Relevant functional departments can master and supervise the basic information of wireless chemicals through the data of network information center and logistics distribution center, realizing the linkage and coordination management of each department, and avoiding the phenomenon of multiple management, and contracting without management. The guarantee of safe transportation of hazardous chemicals is realized through the optimization of business process (Yu et al., 2012).

3.1.2. Optimization of logistics soft environment

The soft environment is mainly the quality of the hazardous chemicals transportation personnel and the supervision personnel and their knowledge of the relevant laws and regulations of the hazardous chemicals. Safety and HSE lessons are provided to the employees by means of training and education, and the sense of safe transportation of the transportation personnel is improved by summarizing the experiences and lessons of the accidents. At the same time, the dangerous chemicals transport personnel shall be trained with the Internet use skills, providing the employees with more information conducive to the logistics transportation of dangerous chemicals from the big data.

3.1.3. Optimization of logistics data-based system

An integrated big data management platform is established by integrating distribution management system, transportation management system, and vehicle route management system, and making use of cloud computing, mass data storage, data mining, distributed processing technology, and diversified query retrieval technology, to realize the optimization of logistics data-based system.

3.2 Logistics Management System Evaluation Method

In the context of big data, the construction of the logistics index system must conform to the characteristics of systematization, data, hierarchy and quantification. The indicators must be able to fully reflect the effect of the optimization of the logistics system and provide help for the business decision-making. Through the optimization design of safety management system of dangerous chemicals logistics, four kinds of optimization indexes are obtained: 1. logistics soft environment, including logistics professionals and logistics personnel training; 2. logistics data indexes, including logistics information control and logistics information docking; 3. logistics flow optimization indexes, including vehicle loading rate, vehicle mileage, and vehicle accident rate; 4.

comprehensive category, logistics cost, and transportation accuracy rate. The evaluation indicators of the logistics management system are shown in Figure 4.

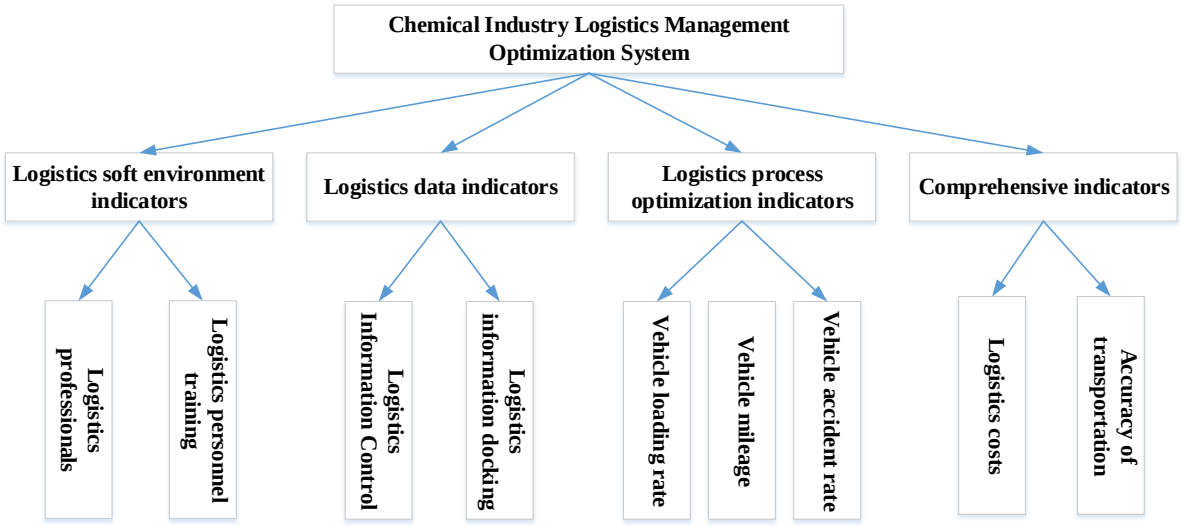

Figure 4: Logistics Management System Evaluation Index

Based on the chemical industry logistics optimization indicator in Figure 4, using such methods as AHP and comprehensive fuzzy evaluation methods, we can provide guidance on the optimization of logistics and transportation of hazardous chemicals for enterprises or regions based on actual conditions.

3.3 Application

Zhenhai District of Ningbo City is an important petrochemical industrial base and a distribution center of liquid chemicals in East China. According to statistics, there are more than 2,500 dangerous chemicals vehicles entering in and out every day, which makes safety supervision task and pressure of dangerous chemicals logistics heavier. Applying the idea of safety management optimization system of dangerous chemicals logistics to the management of dangerous chemicals in the region, the safety inspection and management group and emergency rescue team are established according to local conditions, and the safety performance of the transportation of dangerous chemicals in enterprises is checked and evaluated through big data platform. After nearly two years of application, only 5 dangerous chemical accidents occurred and there were no casualties. The application of logistics safety supervision mode in this area provides reference for the application of big data in hazardous chemicals management system.

4. Conclusions

The frequent accidents in dangerous chemicals logistics have caused a great loss of life and property. In order to establish more perfect dangerous chemicals logistics management system, domestic scholars have carried out many-sided researches. Combined with the opportunity of high-speed development of big data technology, this paper realizes the optimization design of dangerous chemicals logistics management system based on big data. The research significance of this paper is as follows:

(1) Based on big data technology, this paper provides massive, real-time and effective data for hazardous chemical logistics management, and puts forward a set of optimal management scheme.
(2) The optimized management system has achieved good results in practical application.

The research is helpful to promote the informatization of logistics transportation and has important guiding significance to the safety guarantee of hazardous chemicals transportation.

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